BUREAU OF WATER PROTECTION & LAND REUSE
Remediation Division

Environmental Program Fact Sheet

Groundwater Compliance Monitoring Requirements
Remediation Standard Regulations

November 1, 2014

Amendments to the Remediation Standard Regulations, Section 22a-133k-1 through 3 (RSRs) of the Regulations of Connecticut State Agencies became effective June 27, 2013.

This document sets forth the Department of Energy & Environmental Protection's (DEEP) expectations for groundwater monitoring used to demonstrate compliance with the amended Groundwater Remediation Standards of the RSRs.

Because of the RSR amendments, the sections of the March 17, 2006 "Guidance for Groundwater Monitoring for Demonstrating Compliance with the Connecticut Remediation Standard Regulations" that discussed compliance groundwater monitoring have become obsolete. The March 17, 2006 guidance document has been removed from the DEEP webpage. The need for further guidance beyond this fact sheet will be assessed at a later date.

Prior to initiating the collection of groundwater data to demonstrate compliance with the Groundwater Remediation Standards, it is essential that sampling locations used to demonstrate compliance are representative of the plume. This is a pre-requisite for all RSR groundwater standards. "Representative of the plume" means that the sampling locations used to apply applicable criteria of the RSRs accurately reflect the seasonal and dimensional aspects of all substances within the plume. This requires knowledge and understanding of the geologic setting, the hydrogeology of the site and surrounding area, hydrologic conditions (flow paths, flow rates, etc.), the nature of the release, and the fate and transport of the constituents of concern (COCs) in context of the environmental setting. In other words, characterization[1] of the groundwater and plume must precede application of the RSRs.

The methodology of groundwater sampling influences representation. There are numerous documents that have been published that provide guidance for collecting a representative groundwater sample, including but not limited to the following:

- DEEP's "Use of Filters for Groundwater Sampling" (5/1/2012);
- ITRC's "The Use of Direct Push Well Technology for Long-Term Environmental Monitoring in Groundwater Investigations" (March 2006); and
- EPA's "Low Stress (low flow) Purging and Sampling Procedure for the collection of Groundwater Samples from Monitoring Wells (1/19/2010).

[1] "Characterization" means an investigation completed in accordance with prevailing standards and guidelines, including the Site Characterization Guidance Document (SCGD), Rev. December 2010.

In addition, the plume must be in a steady or diminishing state prior to initiating compliance monitoring. This means that the concentrations of substances at each sampling location that represents the extent and degree of the plume are *not increasing over time*, except as a result of either natural attenuation or seasonal variations.

> A steady-state plume is one in which the concentration of substances is not increasing with distance or time (three-dimensional and temporal extent). A diminishing-state plume is one in which the concentrations of substances are not migrating in any direction (steady state or shrinking geographically), whose concentrations are decreasing over time[2].
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> In order for a plume to reach a steady state condition, the source area(s) will require remediation so that no mass of contaminants remains to continue to adversely impact the groundwater. If the plume concentrations do not decrease over time after source removal, then some other condition most likely exists. In this scenario, the cause of this condition must be determined through additional characterization.

The amended RSR provisions that are the focus of this fact sheet are presented below in *italics*, followed by DEEP's explanation, clarification, and expectations for the application of the amended provisions:

22a-133k-3(g) Applying the Criteria for Ground Water.

Ground-water monitoring shall be conducted in accordance with this subsection for any ground-water plume and for any release area remediated in accordance with sections 22a- 133k-1 through 22a-133k-3, inclusive, of the Regulations of Connecticut State Agencies, except for those release areas remediated solely to address exceedances of direct exposure criteria in accordance with section 22a-133k-2(b) [Direct Exposure Criteria].

> For any release that required remediation because substances exceeded the applicable criteria for Pollutant Mobility (PMC), Background, Groundwater Protection (GWPC), Surface Water (SWPC), and/or Volatilization (VolC), groundwater <u>compliance</u> monitoring is required.
>
> If the only remediation necessary at a release area is to address the Direct Exposure Criteria (DEC), groundwater <u>compliance</u> monitoring is not required.
>
> However, adequate characterization of the release area is necessary to determine that substances in soil do not exceed the PMC and that groundwater was not impacted by the release. To ensure that no groundwater will be impacted there should be no potential for residual contamination to exist below the water table. It is expected that the Conceptual Site Model (CSM) describes the nature of the release that resulted in the DEC exceedance(s), but which did not exceed the PMC, and that the release could not have reached the groundwater[3].

[2] Breakdown components resulting from biodegradation of substances in the plume pose an existing or future threat to human health or the environment, and are expected to be considered in the evaluation of nature of the plume.

[3] To ensure groundwater is not impacted by a release typically requires more than one round of groundwater sampling so that any potential seasonal variation may be detected. This will be expected in most cases unless it can be well established that the release was fresh and surficial in nature, and/or the release was a non-soluble material.

22a-133k-3(g)(1) Ground-water Monitoring.

Monitoring shall be designed to determine:

(A) The effectiveness of any soil remediation to prevent the pollution of ground water by substances from the release area;

It is expected that all groundwater monitoring points that are used to demonstrate the effectiveness of the remedial measure are representative of the plume[4] and or potential impact to groundwater from the release area.

(B) The effectiveness of any measures to render soil environmentally isolated;

Measures to render soil environmentally isolated include existing or 'to-be-constructed' buildings, other permanent structures, or engineered controls. These measures require environmental use restrictions to ensure the measure(s) will not be disturbed. Groundwater monitoring is necessary to affirm and document that the measures to render soil environmentally isolated are effective in isolating the soils from groundwater. The potential need for long-term groundwater monitoring, beyond compliance monitoring, may be warranted, on a case-by-case basis, and may be addressed in DEEP's site-specific approval process for an engineered control.

(C) The effectiveness of any remediation taken to eliminate or minimize health or safety risks associated with such release or identified in any risk assessment conducted in accordance with subsection (e)(2) of this section or otherwise identified;

Since groundwater compliance monitoring is not required if remediation was conducted to address DEC only, this section refers to monitoring the effectiveness of measures taken to isolate polluted soils from the groundwater and groundwater remedial measures to eliminate or minimize exposure to polluted groundwater.

Subsection (e)(2) *[Variance Due to Technical Impracticability of Ground-water Remediation]*, presents the expected knowledge and understanding of a groundwater plume, attained through specific groundwater monitoring requirements, to demonstrate the technical impracticability of groundwater remediation and obtain the Commissioner's Approval for such variance[5].

(D) Whether a substance in ground water in a GA area or an aquifer protection area meets the background concentration or ground-water protection criteria, as applicable, in accordance with the provisions of subdivision (2) of this subsection [Compliance with Criteria for Ground Water]*;*

[4] In the context of determining the effective of soil remediation, it would be expected that groundwater quality data had been collected prior to the remedial action in order to later ascertain, through additional groundwater monitoring, the effectiveness of the remedial measure in mitigating groundwater pollution.

[5] Refer to http://www.ct.gov/deep/cwp/view.asp?a=2715&Q=534920&deepNav_GID=1626 for additional information related to Technical Impracticability.

In a GA area or an aquifer protection area, **background groundwater quality is the default goal/criteria.** GWPC may be the target remedial goal only if specific environmental setting requisites, as presented in section (d)(1) and (d)(2) *[Applicability of Groundwater Protection Criteria]*, are present.

The vast majority of GA and aquifer protection areas exhibit a Background groundwater quality that is pristine [natural, unpolluted] and potable. However, there are also many locations within GA areas that exhibit naturally occurring metals/compounds or anthropogenic influences, which present a background condition other than pristine. Therefore:

> Pursuant to 22a-133k-1(a)(5), the "Background concentration for groundwater", with respect to a particular release, means the concentration of a substance in groundwater (A) at the nearest location upgradient of and unaffected by the release; or (B) if such release occurred at or created by a groundwater divide, at the nearest location representative of groundwater quality unaffected by any release. A specific guidance document on Background Conditions is being developed.

There are settings in which a plume may be migrating onto and thereby impacting the groundwater quality on a subject property. For this type of background scenario, DEEP has posted an Environmental Program Policy Statement titled, "Policy on Up Gradient Contamination", dated August 28, 1997. This policy statement remains valid.

If a substance detected in the plume is not listed in Appendix C of the RSRs, a proposed groundwater protection criterion is to be submitted to the Commissioner for approval, pursuant to section 22a-133k-3(h) *[Additional Polluting Substances (APS)]*. Such substance must be included in the groundwater compliance monitoring program.

(E) Whether a substance in ground water meets the surface-water protection criteria and the applicable volatilization criteria in accordance with the provisions of subdivision (2) of this subsection [Compliance with Criteria for Ground Water]*;*

SWPC:
Based on representative sampling of the plume and demonstration that the plume is in a steady or diminishing state, the LEP should be able to determine if the plume attenuates to concentrations meeting applicable criteria prior to discharging to a surface water body (e.g., stream or wetlands). This determination may be at the area immediately upgradient of the point at which such groundwater discharges to the receiving surface-water body. DEEP has accepted representative groundwater data from the leading edge of the plume as an alternative to the point at which the groundwater discharges to the surface water body. However, the LEP must present hydrological information, in relation to fate & transport information of each substance and breakdown products in order to support a demonstration of compliance using the information from the leading edge of the plume.

An alternative to determining compliance with the SWPC immediately upgradient of the point at which such groundwater discharges to the receiving surface-water body, the LEP may calculate the 95% UCL[6] of all substances that are representative of the entire plume in order to demonstrate compliance. This application must take into account the analytical results from each groundwater monitoring location representative of the plume, and from all applicable 'compliance' sampling events. In other words, all analytical results of wells used to represent the plume may be used for the 95% UCL data-set, as long as the sampling events adhere to the compliance monitoring requirements (as explained later in this fact sheet [Section 2(A)(4)(ii)]).

If the plume does discharge to a surface water body, the applicable aquatic life criteria contained in the Water Quality Standards shall also apply, or an alternative SWPC may be calculated for the specific substances, in accordance with section 22a-133k-3(b)(3) *[Alternative surface-water protection criteria]*.

VolC:
All groundwater polluted with a volatile organic substance within 15 feet of the ground surface or a building must meet the provisions of the Volatilization Criteria. Groundwater polluted with a volatile organic substance "within 15 feet of…a building" is the measurement beneath the lowest building level contacting soil and overlying a VOC groundwater plume (e.g., basement floor). If a volatile substance detected in the plume is not listed in Appendix E of the RSRs, a proposed volatilization criteria should be submitted to the Commissioner for APS approval (The alternative of not requesting the Commissioner's approval for APS is to remediate the substance to background).

(F) Whether a ground-water plume in a GB area interferes with any existing use of the ground water for a drinking water supply or with any other existing use of the ground water, including but not limited to industrial, agricultural or commercial purposes.

To identify if the groundwater plume interferes with or has the potential to interfere with any existing use of groundwater, an appropriate receptor survey should be conducted to identify process wells and irrigation wells. A sensitive receptor survey[7] should be conducted to identify drinking water supply wells, even in a GB area,

If it has been determined that there are groundwater usage wells in a GB area impacted by the plume, but an adequate investigation demonstrates that groundwater withdrawn by [potable, irrigation or process] wells is not or will not be at risk of pollution from the plume, then it may be concluded that the plume does not interfere with an 'existing use' of the groundwater.

To support a conclusion that a plume in a GB area does not interfere with an existing use of the groundwater, it should be demonstrated that (i) the plume is in steady or diminishing state; (ii) there is significant distance between the steady or diminishing

[6] Refer to the http://www.ct.gov/deep/lib/deep/site_clean_up/remediation_regulations/95ucl_guidance.pdf for more information on how to calculate a 95% Upper Confidence Level for SWPC.

[7] Refer to the Water Supply Well Receptor Survey Guidance Document for more information on how to conduct a proper receptor survey.

state plume and groundwater withdrawal points; (iii) the plume and withdrawal points are located in different aquifers and/or drainage basins which are not hydrogeologically interconnected; or (iv) the withdrawal point is upgradient of the plume during periods of maximum withdrawal.

If a plume does interfere with an existing use of the groundwater as a *potable supply*, then additional investigation and/or monitoring may be necessary to fully evaluate the risk, and options to mitigate the risk. This scenario will require appropriate notification of a Significant Environmental Hazard, pursuant to 22a-6u of the Connecticut General Statutes.

If a plume does interfere with an existing use of the groundwater for *process or irrigation*, the issue may not necessarily be one of risk to human health, but of economic impact and usability of the water for the intended purpose.

If an existing use of groundwater is permanently discontinued (e.g., by abandoning a contaminated well and/or providing an alternate clean water supply), interference with such prior existing use has then been eliminated. This should be well documented. Possible future uses (e.g., wells that may be installed in the future) are not "existing uses."

Conclusions regarding possible interference with an existing use of groundwater are most appropriately made on a case-by-case basis due to the varied and case-specific circumstances involved. It is important to clearly and completely document the rationale for such conclusions.

(2) Compliance with Criteria for Ground Water.

(A) General.

(i) Analytical results of samples used for determining compliance with an applicable remedial criterion for a substance shall be collected after:

(I) All remedial actions conducted to achieve compliance with pollutant mobility and ground-water criteria for such substance have been concluded, other than natural attenuation of a groundwater plume or the recording of an Environmental Land Use Restriction [ELUR]*;*

The RSRs are 'release-based'; therefore the term, "all remedial actions" pertain to the remedial actions conducted at a specific release area. However, if a site-wide cleanup is the goal, a site-wide groundwater compliance monitoring plan may be conducted to demonstrate compliance, as long as the monitoring wells included in the site-wide plan are representative of all release areas.

Since compliance monitoring must occur after remedial actions have been concluded, groundwater data collected prior to soil remediation cannot be used as part of the four seasonal rounds necessary to achieve compliance monitoring[8].

[8] The seasonality of compliance monitoring is discussed later in this document.

The "other than" reference to natural attenuation is DEEP's expectation that compliance monitoring will be imbedded in the Monitored Natural Attenuation (MNA) program. Compliance monitoring will be necessary in order to demonstrate that the substances in groundwater did attenuate to a concentration that does not exceed the applicable criteria. The concept of MNA and specific requirements to support the MNA approach are discussed in DEEP's Discussion Document presented for DEEP's Wave II RSR expansion[9].

The recording of an ELUR is an administrative action, and is not considered a remedial action. Therefore, the administrative process of recording an ELUR on the land records should not impede or preclude the initiation of compliance monitoring.

(II) The aquifer is no longer subject to the transient effects on hydraulic head attributable to withdrawal from, or injection to, ground water for the purpose of remediation, or other effects due to site redevelopment or remediation;

(III) Any changes to the geochemistry, induced by remedial actions or monitoring well construction methods which might influence the concentration of such substance, have stabilized and equilibrium geochemical conditions are established; and

To demonstrate that the groundwater is no longer being affected by the remedial activities, the monitoring wells need to be properly located to detect both the original groundwater conditions as well as short-term or long-term alterations to the groundwater plume caused during the remediation or site redevelopment. In the event that an in situ remedy has been used to remediate groundwater, the appropriateness of the monitoring points to evaluate the post-remedy conditions must be carefully evaluated using a CSM that is updated to incorporate the details of the remedy and its effect on groundwater.

Without understanding the baseline groundwater conditions prior to initiating remediation, it may be difficult to conclude that the effects of remediation on groundwater conditions have ended and compliance monitoring can commence.

(IV) The concentration of such substance at each sampling location that represents the extent and degree of the ground-water plume is not increasing over time, except as a result of either natural attenuation or seasonal variations.

The entire plume must meet the applicable criteria, including the leading edge of the plume, except as allowed under the optional SWPC compliance provision under 22a-133k-3(g)(2)(C) *[Compliance with Surface-water Protection Criteria]* (ii).

"Not increasing over time" means the plume is in a steady-state or diminishing state. This may only be demonstrated through an adequate characterization of the plume and when groundwater monitoring points are representative of the plume.

[9] Refer to DEEP's http://www.ct.gov/deep/lib/deep/site_clean_up/remediation_regulations/discussiondraft_mna.pdf for further information.

(ii) For determining compliance with an applicable remedial criterion for a substance, a minimum of four sampling events shall be performed[10] which reflect seasonal variability on a quarterly basis, provided that all sampling events used to demonstrate compliance were performed within two years prior to the most current sampling event used to determine compliance, with the exception of monitoring conducted in accordance with subdivision (D)(ii) of this subsection [Compliance with volatilization criteria in soil vapor].

The collection of the four sampling events must occur within two years but does not have to be consecutive. The key is that the sampling must evaluate seasonal variability in different quarters of the year. The sampling requirement is designed to cover the high and low water table events.

The rationale for providing two years to conduct the compliance monitoring is to account for access or logistical issues in the field; this provision makes it possible to complete compliance monitoring without having to start over.

If a reason that a particular seasonal sampling event must be re-created for a particular compliance monitoring point because the well is dry, the LEP should evaluate the applicability of such well as use for appropriate plume representation.

If during the first year of compliance monitoring the concentration exceeds the applicable criteria during one sample round, it may be acceptable to collect another sample during the same quarter the following year. If that sample and three other quarterly samples meet the applicable criteria, compliance monitoring may be complete, as long as it can be demonstrated that the anomalous exceedance was consistent with the goal of confirming the effectiveness of the soil or groundwater remediation. This demonstration will require discussion that:

- the exceedance can be explained and detailed through secondary lines of evidence,
- the difference between the exceedance and the subsequent compliance round is not due to differences in water table elevation, and
- the exceedance is not due to a new source area.

It will also be expected that the LEP provide adequate discussion on the relevancy of the exceedance, and how that particular sampling event influences the LEP's understanding of the plume, the compliance monitoring plan, and application of the RSRs.

Conducting compliance monitoring over one year continues to be acceptable, as long as all monitoring wells meet the appropriate criteria for all four quarters.

[10] Pursuant to subsection (g)(2)(B) *[Compliance with Ground-water Protection Criteria or Background]* (ii), the 95% UCL of the arithmetic mean of all groundwater samples representative of the plume may be calculated using no less than 12 consecutive months of groundwater samples to demonstrate compliance with the GWPC.

(iii) The Commissioner may approve in writing an alternative method of determining compliance with an applicable remedial criterion for a substance utilizing emerging technologies for which guidance, standard or industrial code has been published by a regulatory agency, governmental advisory group, or other recognized professional organization, at the time of the approval.

The key takeaway is that the emerging technology intended to be used for demonstrating compliance must be tested, vetted, and approved for use as a means to demonstrate compliance with groundwater standards by a regulatory agency, governmental advisory group, or other recognized professional organization. Emerging technologies may include both data collection and data interpretation methods that can support a conclusion that the groundwater is in compliance with the groundwater standards.

If you have questions, please contact the Remediation Division of the Bureau of Water Protection and Land Reuse (860-424-3705). All referenced statutes and regulations should be consulted.